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Phytogeographical Affinities of Flora of Nilgiri Biosphere Reserve

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Abstract

Vegetation of the Nilgiri Biosphere Reserve (NBR) was characterized. A total of 5373 individuals above 3.0 cm DBH (Diameter at breast height) belonging to 364 species were enumerated. Phytogeographical affinities of the species was looked into by obtaining information about the species distribution at local and global scale. An analysis of the affinities reveals that NBR flora has strong *Indomalayan* (27.7%) and *Indian* (30.3%) affinities. Flora of moist vegetation types had strong affinities with *Indomalayan* (20.1%); *Indian* (38.6%) and *Indolankan* (9.7%) flora while flora of dry vegetation types had species with *Afrotropical* and *Pantropical* affinities. Tropical montane forest type had maximum number of endemic species (20%) suggesting that the vegetation is highly specialized and requires high priority for conservation.

INTRODUCTION

Nilgiri Biosphere Reserve was established in 1986 by the Department of Environment and Forests as a first step towards conserving the biological diversity of India. The earth summit in Rio de geniro called for the urgent necessity to conserve the biological diversity of the tropics. Global concern about the rate of deforestation of tropical forests accelerated in 1980s. According to estimates of Myers (1986) and FAO (1980) an estimated 14-15 million hectares per annum were deforested. The latest estimate of FAO (1993) put this figure as 15 million hectares per annum or 0.9% of the remaining area of 1750 million hectares. The understanding of the tropical plants by the scientific community is very poor. Most of the taxa is either unknown to the biological world or they are underdescribed. Many of the plants could go extinct before they are given a name (Foster and Hubbell, 1990).

Biogeographically western ghats is the most important region and one of the hot spots for speciation in the tropics. It is the confluence of the afro-tropical and Indomalayan biotic zones of the world. Phytogeographically the vegetation of India is analysed into distinct botanical provinces based on criteria like species and familial composition of the flora (Hooker, 1907) and climate (Prain, 1903). Udavardy (1975) divided the Indian subcontinent into twelve distinct biogeographic provinces. Nilgiri biosphere reserve lies in the botanical provinces of Malabar and Deccan. Malabar province lies between the river Tapti in north and Kanyakumari in the

south. It is a humid tropical belt of mountainous region bearing the fury of the south-west monsoon and hosts a luxuriant seasonal rain forest in the lowland. In the higher reaches of the mountains an unique phyto association of tropical Montane forest and grassland is found. As it progresses east the vegetation gradually changes to moist deciduous to scrub through dry deciduous in the Deccan plateau. The Deccan plateau constitutes a distinct biographical province, but the transformation is not rigid.

In recent years the area under forest cover has drastically reduced (NRSA, 1993) due to various anthropogenic pressures. As a result, drastic changes in the landscape of the western ghats has occurred resulting in the loss of pristine forests (Subhash Chandran and Gadgil, 1993). According to IPCC (1996) global models based on 2 x CO_2 climate project that a substantial fraction of the existing forest will experience climatic condition under which they currently do not exist. Thus a large forested area will undergo change from current forest type to new major vegetation type (for a detailed review refer Ravindranath and Sukumar, 1997). Impact of climate change on the biodiversity is rather speculative at this stage. Thus serious attempts should be made to assess the potential impacts of the climate change on the forest diversity. An improved understanding of impacts of climate change would enable forest managers to develop mitigation and adaption measures to minimize the adverse impacts. Understanding of the phytogeographical affinities would help the forest managers and policy makers in making the right choice of species. This paper addresses the following questions: (1) What is the broad phytogeographical pattern of the Biosphere reserve ? (2) What is the phytogeographical associations of each forest community? How is the pattern of endemism? and also endemism is discussed with special reference to tropical Montane communities.

MATERIAL AND METHODS

Study area

This study was conducted in the Nilgiri Biosphere Reserve comprising three States of Karnataka, Kerala and Tamil Nadu. The biosphere reserve extends over 5500 sq. km. comprising of the whole of Nilgiri district, parts of Coimbatore plains. To the north is Mysore plateau consisting of Bandipur National Park and Segur plateau. To the west is Wynaad sanctuary, Silent Valley National Park and Nilambur plains. To the south is Attapadi plateau and contiguous stretch of Coimbatore plains (Fig. 1).

Sampling

A standard 0.1 ha sampling method was followed to sample the vegetation. A 250 x 4 meter length transect in strips of 50 meters was laid randomly. All plants above 3.0 cm diameter at breast height were identified and enumerated for their girth, a qualitative estimate of the height and height at first branch was done. At every 10 meters a qualitative estimate of the canopy was done. Samples were collected for the herbarium.

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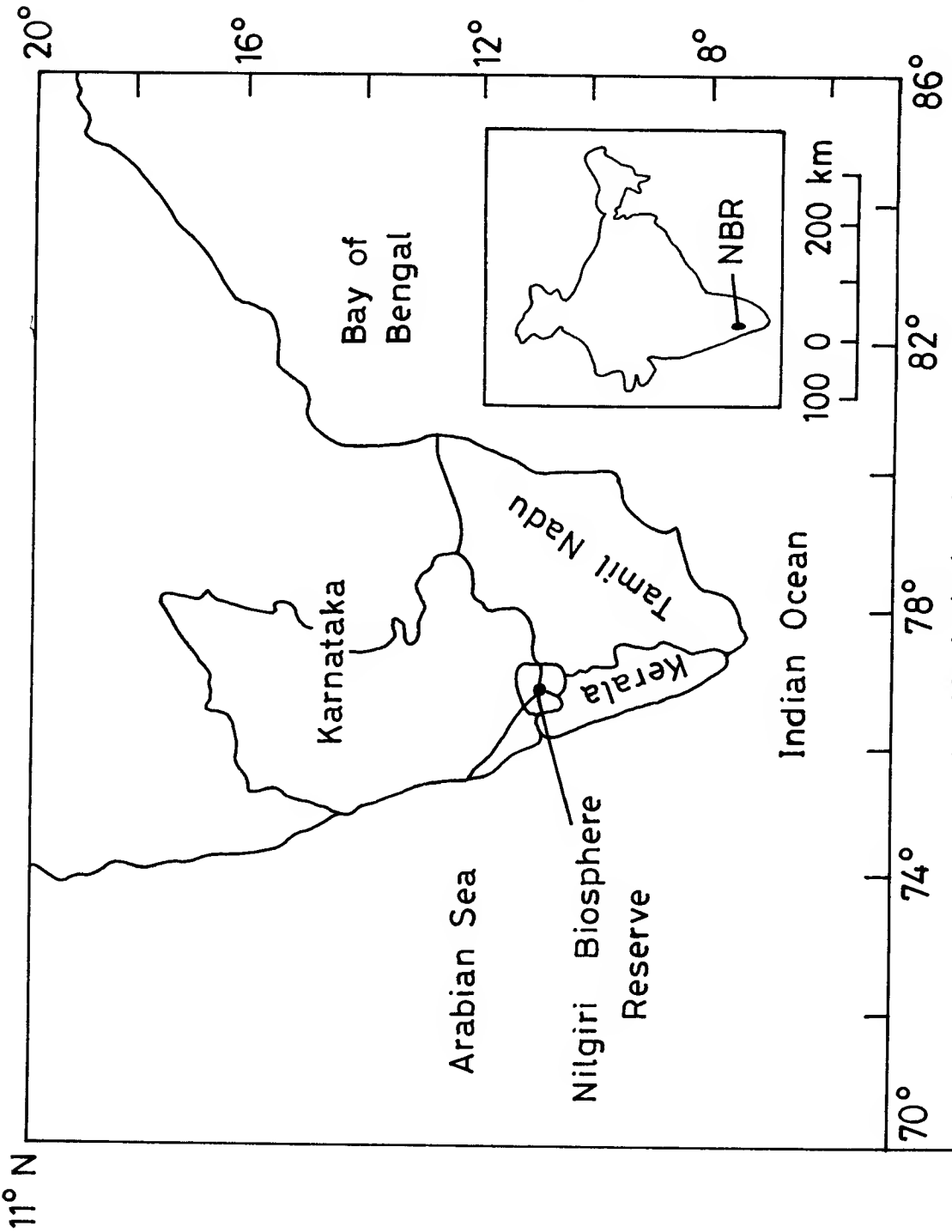

Fig. 1. Map showing the study area

Data for each forest type regarding species composition was obtained by pooling the data from each 0.1 ha sample from the respective forest types. A master list for each forest type was prepared. The phytogeographical affinity was obtained from different floras and other relevant literature. Data was analysed for various affinities: within forest types and across forest types. 60 such transects were laid randomly in different vegetation types and in different geographical locations.

RESULTS AND DISCUSSION

A total of 5373 individuals belonging to 364 species were enumerated in different forest types located in different geographical locations. Biogeography of the Indian sub-continent should be viewed with the understanding of the plate tectonics that has resulted in the current physiography. The floristic elements of India share both Afro-tropicaland Tropical-Asian elements. But predominantly they share the affinity with the Indo-malayan realm (Daniel and Nair, 1985). Significant number of species in Nilgiri biosphere reserve showed either Indomalayan (27.78%) or Indian affinities (30.05%), thus corroborating the earlier results on the phytogeographical affinities (Subramanyam and Nayar, 1974; Razi, 1955-56). A total of 11.7% of species constituted unknown category of species whose affinities could not be ascertained as their identity was not certain. However, the conclusions will not change since the species are of either Indian or Indomalayan affinity. Figure 2 represents the percentage of the species showing various affinities when all the samples were pooled together. Analysis of the affinity based on number of individuals represented by various species also shows similar trend. Many individuals are of either Indian (37.4%) or Indomalayan (22.69%). Only 3% of the total number of individuals are in the unknown category. Table 1 presents the data on affinities of various species in each forest type. There are two distinct patterns of the affinity. The drier forest communities had the representations of species from Indo-Pak (0.65%) or Indo-African (2.55%) realm suggesting the migrations of the species from the dry belt, eventhough majority of the species showed Indomalayan affinity (30.35%). The drier forest communities seemed to be more generalistic in nature accounted for 10% of the species complements having a broad phytogeo-graphical range. Some species predominantly of neotropical origin also had representation. The wetter forest communities were more specialised communities by harbouring more than 50% of the species complements having a narrow geographical range. They also had 18.98% endemic species. The wetter forest communities predominantly show either Indian (33.8%) or Indo-malayan (24.07%) affinity suggesting migrations from more wetter belts.

Phytogeographical Affinities

Table 1 Phytogeographical Affinities of Various Vegetation Types in Nilgiri Biosphere Reserve (Affinities are in percent)

Affinity	Thorn Scrub	Riverine	Dry Deciduous	Moist Deciduous	Evergreen	Shola
Trop-Asia	0	0	5.49	0	0.84	0
Paleo Tropics	8.69	11.76	4.39	2.94	2.52	1.03
Indopak	0	0	2.19	0	0	0
Indian	28.98	17.64	31.86	27.45	38.65	27.83
Indo African	4.34	3.92	1.09	1.96	0	0
Indo Malayan	27.53	29.41	34.06	29.41	20.16	28.86
Endemic	0	0	4.39	1.96	18.48	19.58
Unknown	8.69	11.76	10.98	18.62	5.88	14.43
Neo Tropics	0	196	0	0	0	0
Pan Tropics	7.24	0	0	0.98	2.52	0

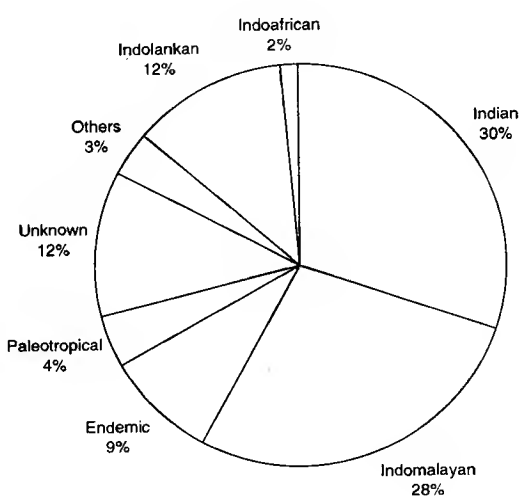

Fig. 2. Phytogeographical affinities of Nilgiri Biosphere Reserve

Affinities of plant species from the dry zone

Many species in this zone show wide distribution. This zone is also characterised by plants belonging to Pakistan and Africa. Plants in the dry deciduous forest zone have either Indian (31.86%) or Indomalayan (34.06%) affinity. Important species forming the association of the forest of peninsula shows following affinities : *Angeissus latifolia* (Indian), *Terminalia crenulata* (Indian) and *Tectona grandis* (Indo-malayan). Other important species like *Dalbergia latifolia, Pterocarpus marsupium, Ougeinia oojensis, Stereospermum personatum* shows affinities with Indian flora. Whereas species like *Cassine glaucum, Garuga pinnata, Gmelina arborea* and *Schleichera oleosa* shows affinities with Indomalyan flora. This trend is true of understory species also. Species like *Kydia calycina, Bridelia retusa, Vitex altissima, Careya arborea* show affinities with Indian flora. Whereas species such as *Emblica officinalis, Cassia fistula, Wrightia tinctoria, Bauhinia racemosa* show affinities with Indomalayan flora. The dry forest flora has affinities with African tropics with some species in the forests showing the Afro-tropical affinities. Species such as *Grewia tiliifolia* and *Alstonia scholaris* in the canopy and *Xeromphis spinosa* in the understory show African affinities.

The dry thorn forest to a large extent has similar pattern with Indian (28.9%) and Indomalayan (27.5%) elements dominating the flora. Important species forming the facies of the forest *Gyrocarpus jacquinii* (tropical), *Acacia chundra* (Indian), *Acacia ferruginea* (Indian), *Acacia leucophloea* Indomalayan. This community also has species of African affinity, for example *Albizia chinensis* a canopy species, *Albizia lebbeck, Acacia pennata.* Details of individual species affinity is given in (Tables 1-2).

Table 1: Phytogeographical Affinities of Plants in the Dry Thorn Forest Zone

Species	Family	Affinity
Acacia chundra	Fabaceae	Indolankan
Acacia ferruginia	Fabaceae	Indian
Acacia leucophloea	Fabaceae	Indomalayan
Acacia pennata	Fabaceae	Paleotropical
Ailanthus excelsa	Simorubaceae	Indolankan
Albizia amara	Fabaceae	Indoafrican
Albizia amara	Fabaceae	Indoafrican
Albizia chinensis	Fabaceae	Indomalayan
Albizia chinensis	Fabaceae	Paleotropical
Albizia procera	Fabaceae	Indomalayan
Anogeissus latifolia	Combretaceae	Indian
Atlantia hexapetala	Rutaceae	Indian
Azadiracta indica	Meliaceae	Indomalayan

Phytogeographical Affinities

Species	Family	Affinity
Bauhinia racemosa	Fabaceae	Indomalayan
Butea monosperma	Fabaceae	Indomalayan
Canthium dicoccum	Rubiaceae	Indian
Canthium parviflorum	Rubiacaea	Indian
Capparis grandiflora	Capparaceae	Indian
Capparis zeylanica	Capparaceae	Indomalayan
Carissa carandas	Apocynaceae	Indian
Chloroxylon swietenia	Rutaceae	Indolankan
Chomelia asiatica	Rubiaceae	Indomalayan
Chlausena indica	Rutaceae	Indolankan
Commiphora berryei	Burseraceae	Indian
Commiphora caudata	Burseraceae	Indolankan
Dalbergia lanceolaria	Fabaceae	Indolankan
Dendrocalamus strictus	Poaceae	Indian
Dichrostachys cinerea	Fabaceae	Paleotropical
Diospyros montana	Ebenaceae	Indomalayan
Ehretia canarensis	Boraginaceae	Indian
Casine glauca	Celastraceae	Indomalayan
Emblica officinalis	Euphorbiaceae	Paleotropical
Erythroxylon monogynum	Erythroxylaceae	Indian
Euphorbia antiquorum	Euphorbiaceae	African
Flacourtia indica	Flacourtiaceae	Pantropical
Flacourtia montana	Flacoutiaceae	Pantropical
Gardenia turgida	Rubiaceae	Indian
Givotia rottleriformis	Euphorbiaceae	Indian
Grewia abutilifolia	Tiliaceae	Indomalayan
Gyrocarpus americanus	Hemandiaceae	Pantropical
Hardwickia binata	Fabaceae	Indian
Ixora nigricans	Rubiaceae	Indomalayan
Jatropha glandulifera	Euphorbiaceae	Indoafrican
Mallotus philippensis	Euphorbiaceae	Indomalayan
Maytenus emarginatus	Celastraceae	Indomalayan
Miliusa velutini	Annonaceae	Indian
Moringa concaneneis	Moringaceae	Indian
Plerostylis opposita	Celastraceae	Indomalayan
Plerostylis wightii	Celastraceae	Indomalayan

Species	Family	Affinity
Premna tomentosa	Verbenaceae	Indolankan
Prosopis juliflora	Fabaceae	Indomalayan
Pterolobium hexapetalum	Fabaceae	Indian
Rhus mysorensis	Anacardiaceae	Indian
Santalum album	Santalaceae	Indian
Sapindus emarginatus	Sapindaceae	Indolankan
Scutia myrtina	Rhamnaceae	Indolankan
Strychnos potatorum	Loganiaceae	Indolankan
Tamarindus indica	Fabaceae	Tropical
Wrightia tinctoria	Apocynaceae	Indomalayan
Xeromphis spinosa	Aubiaceae	Paleotropical
Ziziphus oenoplea	Rhamnaceae	Pantropics
Ziziphus xylopyrus	Rhamnaceae	Indian

Table 2 : Phytogeographical Affinities of Plants in the Dry Deciduous Forest Zone

Species	Family	Affinity
Acronychia pedunculata	Rutaceae	Indomalayan
Actinodaphne malabarica	Lauraceae	Endemic
Albizia chinensis	Fabaceae	Indomalyan
Albizia lebbeck	Fabaceae	Paleotropical
Alseodaphne semecarpifolia	Lauraceae	Indolankan
Anogeissus latifolia	Combretaceae	Indian
Atlantia hexapetala	Rutaceae	Indian
Bambusa arundinacea	Poaceae	Indian
Bauhinia racemosa	Fabaceae	Indomalayan
Bridelia retusa	Euphorbiaceae	Indian
Buchanania lanzan	Anacardiaceae	Indian
Butea monospema	Fabaceae	Indomalayan
Canthium dicoccum	Rubiaceae	Indomalayan
Cassia fistula	Fabaceae	Indomalayan
Cedrela toona	Meliaceae	Tropical Asia-Australia
Chloroxylon swietenia	Rutaceae	Indian
Chomelia asiatica	Rubiaceae	Indomalayan
Cipedessa baccifera	Meliaceae	Indomalayan

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Species	Family	Affinity
Clausena hexapetala	Rutaceae	Indomalayan
Clausena indica	Rutaceae	Indolankan
Commiphora caudata	Burseraceae	Indian
Cordia macleodii	Boraginaceae	Indian
Cordia obiliqua	Boraginaceae	Indopak
Cordia wallichii	Boraginaceae	Indian
Cassine glauca	Celastraceae	Indomalayan
Dalbergia latifolia	Fabaceae	Indomalayan
Dalbergia lanceolaria	Fabaceae	Indolankan
Diospyros montana	Ebenaceae	Tropica Asia-Australia
Emblica officinalis	Euphorbiaceae	Paleotropical
Epiprinus mallotiformis	Euphorbiaceae	Endemic?
Eriolaena quinquilocularis	Sterculiaceae	Indian
Erythroxylon monogynum	Erythroxylaceae	Indian
Ficus tsjeckela	Moraceae	Indolankan
Ficus virens	Moraceae	Indomalayan
Givotia rottleriformis	Euphorbiaceae	Indian
Glochidion sp.	Euphorbiaceae	Indopak
Glochidion zeylanicum	Euphorbiaceae	Indomalayan
Gmelina arborea	Verbenaceae	Indomalayan
Grewia tiliifolia	Tiliaceae	Indoafrican
Helicteres isora	Sterculiaceae	Tropical Asia-Australia
Ixora nigricans	Rubiaceae	Indomalayan
Kydia calycina	Malvaceae	Indian
Lagerstroemia microcarpa	Lythraceae	Indian
Lagerstroemia parviflora	Lythraceae	Indian
Ligustrum roxburghii	Oleaceae	Indian
Litsea floribunda	Lauraceae	Endemic
Mallotus philippensis	Euphorbiaceae	Tropical Asia-Australia
Milusa velutina	Annonaceae	Indian
Moringa concanensis	Moringaceae	Indomalayan
Morinda sp.	Apocynaceae	Indomalayan
Naringi crenulata	Rutaceae	Indomalayan
Olea dioica	Oleaceae	Indian
Ougenia oojensis	Fabaceae	Indian

Species	Family	Affinity
Pterocarpus marsupium	Fabaceae	Indian
Radermachera xylocarpa	Bignoniaceae	Indian
Sapindus emarginatus	Sapindaceae	Indolankan
Schlechera oleosa	Sapindaceae	Indomalayan
Schrebera swietenioides	Oleaceae	Indomalayan
Semecarpus anacardium	Anacardiaceae	Indian
Solanum xanthocarpum	Solanaceae	Indomalayan
Strychnos potatorum	Loganiaceae	Indomalayan
Syzygium cumini	Myrtaceae	Tropical Asia-Australia
Tamarindus indica	Fabaceae	Paleotropical
Tectona grandis	Verbenaceae	Indomalayan
Terminalia bellerica	Combretaceae	Indomalayan
Terminala chebula	Combretaceae	Indian
Terminalia paniculata	Combretaceae	Indian
Terminalia crenulata	Combretaceae	Indian
Trema orientalis	Ulmaceae	Indomalayan
Uvaria racemosa	Annonaceae	Endemic?
Viburnum punctatum	Caprifoliaceae	Indomalayan
Vitex altissima	Verbenaceae	Indian
Wrightia tinctoria	Apocynaceae	Indomalayan
Xeromphis spinosa	Rubiaceae	Paleotropical
Xylia xylocarpa	Fabaceae	Indomalayan
Ziziphus rugosa	Rhamnaceae	Indian
Ziziphus xylopyrus	Rhamnaceae	Indian

Contrasting with the moist formations, the floristic elements show significantly less number of Indolankan affinity suggesting that the species migration from the dry African savanna through the desert of gulf and colonized the dry plains of Deccan plateau. These dry forest formations can be referred to more generalist habitat as they signify species which have wider range. Dry deciduous forest has (4.39 %) of species which show paleotropical distribution, having also large representation in riverine type (11.76%) and thorn scrub (8.69 %).

Affinities of moist formation

The wet evergreen forests on the windward side of the ghats has species typically of either Indian (38.65%) or Indomalayan (20.16%). The canopy species like *Palaquium ellipticum* (In-

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dian), *Cullenia exarillata* (Indian), *Mesua ferrea* (Indian) are some of the examples of Indian affinity. The occurrence of genera like *Poeciloneuron indicum, Hydnocarpus* in the canopy and *Apodytes, Gomphanrda* in the understory are the relics of the *Gondwana* which Indian sub-continent was a part and proves phytogeographically the past connections with the present continents. Evergreen forests has (18.4%) of endemic species. The occurrence of the genus, *Nothopodytes* in the Montane forests indicates the amplitude of the species. This zone has endemics also but not significant proportion of the species (19 %). Endemics are concentrated in the families such as Lauraceae, Annonaceae (*Polyalthia*), Clusiaceae (*Garcinia, Calophyullum*). Details of the species affinities are presented in the Table 3-5.

Table 3 : Phytogeographical Affinities of Plants Belonging to Moist Deciduous Forest Zone

Species	Family	Affinity
Albizia odoratissima	Fabaceae	Indomalayan
Allophyllus cobbe	Sapindaceae	Indomalayan
Anogeissus latifolia	Combretaceae	Indolankan
Anthocephalus chinensis	Rubiaceae	Indian
Baccaurea courtalensis	Euphorbiaceae	Indian
Bauhinia malabarica	Fabaceae	Indian
Bauhinia racemosa	Fabaceae	Indian
Bombax ceiba	Bombacaceae	Indomalayan
Bridelia retusa	Euphorbiaceae	Indomalayan
Careya arborea	Lecythidaceae	Indolankan
Casearia esculenta	Flacourtiaceae	Indolankan
Casearia wynadensis	Flacourtiaceae	Indian
Cassia fistula	Fabaceae	Indomalayan
Cassia montana	Fabaceae	Indian
Cinnamomum malabathrum	Lauraceae	Endemic
Cipadessa baccifera	Meliaceae	Indomalayan
Cordia macleodi	Boraginaceae	Indomalayan
Cordia obliqua	Boraginaceae	Indoafrican
Cordia wallichii	Boraginaceae	Indian
Cycas circinalis	Cycadaceae	Indian
Dalbergia latifolia	Fabaceae	Indomalayan
Dalbergia lanceolaria	Fabaceae	Indomalayan
Dendrocalamus strictus	Poaceae	Indian
Desmodium pulchellum	Fabaceae	Indomalayan
Dillenia pentagyna	Dilleniaceae	Indomalayan

Species	Family	Affinity
Diospyros montana	Ebenaceae	Indomalayan
Dolichandrone falcata	Bignoniaceae	Indian
Emblica officinalis	Euphorbiaceae	Paleotropical
Eriolaena quinquilocularis	Sterculiaceae	Indian
Ervatamia heyneana	Apocynaceae	Indian
Ficus religiosa	Moraceae	Indomalayan
Ficus tsjeckela	Moraceae	Indolankan
Flacourtia sp.	Flacourtiaceae	Indian
Garcinia morella	Clusiaceae	Indomalayan
Glochidion velutinum	Euphorbiaceae	Indian
Gmelina arborea	Verbenaceae	Indomalayan
Grewia orbiculata	Tiliaceae	Indian
Helicteres isora	Sterculiaceae	Paleotropics
Grewia tilifolia	Tiliaceae	Indoafrican
Holigarmna grahamii	Anacardiaceae	Indian
Ixora arborea	Rubiaceae	Indolankan
Ixora nigricans	Rubiaceae	Indian
Kydia calycina	Malvaceae	Indian
Lagerstroemia microcarpa	Lythraceae	Indian
Lannea coramandelica	Anacardiaceae	Indolankan
Leea indica	Leeaceae	Indomalayan
Litsea mysorensis	Lauraceae	Endemic
Macaranga peltata	Euphorbiaceae	Indolankan
Mallotus philippensis	Euphorbiaceae	Indomalayan
Morinda sp.	Apocynaceae	Indomalayan
Naringi crenulata	Rutaceae	Indomalayan
Olea dioica	Oleaceae	Indian
Olea glandulifera	Oleaceae	Indian
Palaquim ellipticum	Sapotaceae	Indian
Pavetta indica	Rubiaceae	Indian
Pterocarpus marsupium	Fabaceae	Indolankan
Radermachera xylocarpa	Bignoniaceae	Indomalayan
Sapindus emarginatus	Sapindaceae	Indolankan
Schleichera oleosa	Sapindaceae	Indomalayan
Schrebera switeinoides	Oleaceae	Indian

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Species	Family	Affinity
Scolopia crenata	Flacourtiaceae	Indomalayan
Semecarpus anacardium	Anacardiaceae	Paleotropical
Solanum torvum	Solanaceae	Pantropical
Sterculia guttata	Sterculiaceae	Indolankan
Stereospermum personatum	Bignoniaceae	Indolankan
Sterculia urens	Sterculiaceae	Indolankan
Syzygium cumini	Myrtaceae	Indomalayan
Syzygium gardneri	Myrtaceae	Indolankan
Tectona grandis	Verbenaceae	Indomalayan
Terminalia bellerica	Combretaceae	Indomalayan
Terminalia paniculata	Combretaceae	Indian
Terminalia crenulata	Combretaceae	Indian
Toona ciliata	Meliaceae	Indomalayan
Trichelia connoroides	Meliaceae	Indian (Pantropical?)
Vitex altissima	Verbenaceae	Indian
Wrightia tincotoria	Apocynaceae	Indomalayan
Xylia xylocarpa	Fabaceae	Indomalayan
Ziziphus rugosa	Rhamnaceae	Indolankan
Ziziphus xylopyrus	Rhamnaceae	Indian

Table 4 : Phytogeographical Affinities of Plants Belonging to Evergreen Forest Zone

Species	Family	Affinity
Achronychia pedunculata	Rutaceae	Indomalayan
Actinodaphne lawsonii	Lauraceae	Endemic?
Actinodaphne malabarica	Lauraceae	Endemic
Aglaia elaegnoidea	Meliaceae	Indomalayan
Aglaia sp.	Meliaceae	Indomalayan
Agrostistachys bourdilloni	Euphorbiaceae	Indolankan
Agrostistachys meeboldii	Euphorbiaceae	Indolankan
Antidesma menasu	Euphorbiaceae	Indian
Aphanamixis polystachya	Meliaceae	Indomalayan
Apollonias amottii	Lauraceae	Endemic
Artocarpus hirsutus	Moraceae	Indian

Species	Family	Affinity
Atlantia wightii	Rutaceae	Endemic
Bischofia javanica	Euphorbiaceae	Indomalayan
Calophyllum apetalum	Clusiaceae	Endemic
Calophyllum polyanthum	Clusiaceae	Endemic
Canthium dicoccum	Rubiaceae	Indomalayan
Casearia esculenta	Flacourtiaceae	Indolanakan
Casearia ovoides	Flacourtiaceae	Indian
Casearia wynadensis	Flacourtiaceae	Indian
Cinnamomum malabathrum	Lauraceae	Endemic
Cinnamomum sulphuratum	Lauraceae	Endemic
Clerodendron viscosum	Verbenaceae	Indomalayan
Cryptocareya bourdillonii	Lauraceae	Endemic?
Cycas racemosus	Cycadaceae	Endemic
Cassine glauca	Celastraceae	Indomalayan
Daphniphyllum neilgherrense	Euphorbiaceae	Sino-Indomalayan
Democarpus longan	Sapindaceae	Tropical
Diospyros niqrescens	Ebenaceae	Indian
Diospyros oocarpa	Ebenaceae	Indian
Diospyros paniculata	Ebenaceae	Indolankan
Diospyros sylvatica	Ebenaceae	Indolankan
Drypetes elata	Euphorbiaceae	Indian
Elaeocarpus munronii	Elaeocarpaceae	Indian
Elaeocarpus tuberculatus	Elaeocarpaceae	Indomalayan
Epiprinus mallotiformis	Euphorbiaceae	Indian
Erythroxylon moonii	Erythroxylaceae	Indian
Euonymus crenulatus	Celastraceae	Indian
Euonymus umbellatus	Celastraceae	Indian
Eurya nitida	Theaceae	Indomalayan
Farenheitia zeylanica	Euphorbiaceae	Indolanakan
Ficus amotiana	Moraceae	Indolankan
Ficus beddomei	Moraceae	Indian
Ficus nervosa	Moraceae	Indomalayan
Garcinia gummigutta	Clusiaceae	Endemic
Garcinia morella	Clusiaceae	Endemic
Garcinia sp.	Clusiaceae	Indian

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Species	Family	Affinity
Garuga pinnata	Burseraceae	Indian
Gomphandra tetrandra	Icacinaceae	Indomalayan
Gordonia obtusa	Theaceae	Indian
Hedyotis sp.	Rubiaceae	Indian
Hereteria papillo.	Sterculiaceae	Indian
Holigarna nigra	Anacardiaceae	Indian
Hopea glabra	Dipterocarpaceae	Indian
Hydnocarpus alpina	Flacourtiaceae	Indolankan
Isonandra lanceolata	Sapotaceae	Indolankan
Jatropha glandulifera	Euphorbiaceae	Paleotropical
Lagerstroemia reginae	Lythraceae	Indomalayan
Lasianthus sp.	Rubiaceae	Indian
Leea indica	Leeaceae	Indomalayan
Laportea crenulata	Urticaceae	Paleotropical
Laportea interrupta	Urticaceae	Endemic
Litsea bourdillonii	Lauraceae	Endemic
Litsea floribunda	Lauraceae	Endemic
Litsea insignis	Lauraceae	Endemic
Litsea stocksii	Lauraceae	Endemic
Macaranga peltata	Euphorbiaceae	Indolankan
Mallotus philippensis	Euphorbiaceae	Indomalayan
Moallotus stenanthus	Euphorbiaceae	Indomalayan
Mangifera indica	Anacardiaceae	Tropics
Mastixia arborea	Cornaceae	Indian
Meliosma pinnata	Sabiaceae	Indomalayan
Memecylon heyneanum	Melastomaceae	Indian
Mesua ferrea	Clusiaceae	Indian
Mesua negassaria	Clusiaceae	Indomalayan
Milusa montana	Annonaceae	Indian
Myristica dactyloides	Myristicaceae	Indolanakan
Neolitsea scrobiculata	Lauraceae	Indian
Neolitsea zeylanica	Lauraceae	Indomalayan
Nothopegia beddomei	Anacardiaceae	Indian
Olea dioica	Oleaceae	Indian
Oreocnide crenulata	Urticaceae	Indian

Species	Family	Affinity
Palaquium ellipticum	Sapotaceae	Indian
Persea macarantha	Lauraceae	Indolanakan
Poeciloneuron indicum	Clusiaceae	Indian
Prunus ceylanica	Rosaceae	Indomalayan
Psychotria sp.	Rubiaceae	Indian
Pterogota alata	Sterculiaceae	Indian
Reinwarditiodendron anamalayana	Meliaceae	Indian
Scolopia crenata	Flacourtiaceae	Indomalayan
Symplocos cochinchinensis	Symplocaceae	Indomalayan
Symplocos marocarpa	Symplocaceae	Indian
Symplocos pulchera	Symplocaceae	Indian
Symplocos sp.	Symplocaceae	
Syzygium densiflorum	Myrtaceae	Indian
Syzygium gardneri	Myrtaceae	Indolankan
Syzygium heyneanum	Myrtaceae	Indian
Syzygium keralensis	Myrtaceae	Endemic?
Syzygium laetum	Myrtaceae	Endemic?
Syzygium munronii	Myrtaceae	Indian
Syzygium negasserium	Myrtaceae	Endemic?
Syzygium sp.	Myrtaceae	
Ternstroemia japonica	Ternstroemiaceae	Indomalayan
Tricalysia apiocarpa	Rubiaceae	Indian
Trichelia connorioides	Meliaceae	Tropical
Turpinia malabarica	Staphyllaceae	Indian
Vernonia arborea	Asteraceae	Indian
Xanthophyllum amottiana	Xanthophyllaceae	Indolankan
Zanthophyllum arnotiana	Rutaceae	Indomalayan

Table 5 : Phytogeographical Affinities of Plants Belonging to Shola Forest Zone

Species	Family	Affinity
Achronychia pedunculata	Rutaceae	Indomalayan
Actinodaphne malabarica	Lauraceae	Endemic
Alseodaphne semecarpifolia	Lauraceae	Endemic

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Species	Family	Affinity
Antidesma sp.	Euphorbiaceae	Indian
Apodytes dimitida	Icacinaceae	Paleotropical
Belishemiedia wightii	Lauraceae	Indian
Celtis tetrandra	Ulmaceae	Indomalayan
Cinnamomum malabathrum	Lauraceae	Endemic
Cinnamomum sulphuratum	Lauraceae	Endemic
Daphniphyllum neilgherrensis	Euphorbiaceae	Indomalayan
Drypetes elata	Euphorbiaceae	Indian
Elaeocarpus oblongus	Elaeocarpaceae	Indian
Elaeocarpus recurvatus	Elaeocarpaceae	Indomalayan
Elaeocarpus tuberculatus	Elaeocarpaceae	Indomalayan
Euonymus crenulatus	Celastraceae	Indian
Euonymus undulatus	Celastraceae	Indian
Eurya nitida	Theaceae	Indomalayan
Excoecarea neilgherrensis	Euphorbiaceae	Indian
Evodia lunu-annkenda	Rutaceae	Indomalayan
Garcinia gummigutta	Clusiaceae	Endemic
Glochidion neilgherrensis	Euphorbiaceae	Endemic
Glochidion velutinum	Euphorbiaceae	Indian
Gordonia obtusa	Theaceae	Endemic
Hydnocarpus alpina	Flacourtiaceae	Indolankan
Illex dentifulata	Aquafoliaceae	Indian
Illex wightiana	Aquafoliaceae	Indian
Isonandra candolleana	Sapotaceae	Indian
Jasminum roxburghi	Oleaceae	Indian
Lasianthus coffeoides	Rubiaceae	Indian
Lasianthus venulosus	Rubiaceae	Indian
Litsea coriacea	Lauraceae	Endemic
Litsea deccanensis	Lauraceae	Endemic
Litsea floribunda	Lauraceae	Endemic
Litsea ghatica	Lauraceae	Endemic
Litsea mysorensis	Lauraceae	Endemic
Litsea stocksii	Lauraceae	Endemic
Litsea wightiana	Lauraceae	Endemic
Mahonia leschenaultiana	Berberidaceae	Endemic
Mallotus philippensis	Euphorbiaceae	Indomalayan

Species	Family	Affinity
Meliosma simplicifolia	Sabiaceae	Indolankan
Memecylon malabaricum	Melastomaceae	Indian
Michelia nilagirica	Magnoliaceae	Endemic
Microtopis racemosa	Celastraceae	Indolankan
Neolitsea scrobiculata	Lauraceae	Indian
Neolitsea zeylanica	Lauraceae	Indomalayan
Nothapodytes foetida	Icacinaceae	Indomalayan
Nothopegia heyneana	Anacardiaceae	Indian
Photinia indica	Rosaceae	Indomalayan
Phoebe lanceolata	Lauraceae	Indian
Phoebe paniculata	Lauraceae	Endemic
Phoebe wightii	Lauraceae	Endemic
Pittosporum floribunda	Pittosporaceae	Indian, Temperate Asia
Polyalthia cffeoides	Annonaceae	Indolankan
Psychotria congesta	Rubiaceae	Indian
Psychotria bisulcata	Rubiaceae	Indian
Rapanea wightii	Myrsinaceae	Indolankan
Rhododendron nilagiricum	Ericaceae	Endemic
Schefflera macrantha	Araliaceae	Indian
Scolopia crenata	Flacourtiaceae	Indomalayan
Symplocus beddomei	Symplocaceae	Indian
Symplocus cochinchinensi	Symplocaceae	Indomalayan
Symplocus foliosa	Symplocaceae	Indian
Symplocus macrocarpa	Symplocaceae	Indian
Symplocus obtusa	Symplocaceae	Indian
Symplocus rosea	Symplocaccae	Indian
Syzygium amottiana	Myrtaceae	Indian
Syzygium cumini	Myrtaceae	Indomalayan
Syzygium densiflorum	Myrtaceae	Indian
Syzygium montana	Myrtaceae	Indian
Ternstroemia japonica	Ternstroemiaceae	Indomalayan
Trema orientalis	Ulmaceae	Paleotropical
Turpinia nepalensis	Staphyllaceae	Indomalayan
Viburnum sp.	Caprifoliaceae	
Webera coffeoides	Rubiaceae	Indian
Withania somnifera	Solanaceae	Indoafrican

Phytogeographical Affinities

The flora of the mountain tops show interesting features. Nilgiris which forms an out crop of western ghats began its uplift during pliocene time and the rise was gradual. The tropical species could evolve and survive under the shola canopy whereas some species of the high latitudes are seen in the grasslands (Meher-Homji, 1988). The sholas have large representation of species which are confined to Indian (27.83%), Indolankan (8.24%) or Indomalayan (28.86%) region. *Daphniphyllum* and *Eurya japonica* are two exceptions being from the high latitudes and yet having representation in the shola. Some Himalayan elements like *Rhododendron, Berberis tinctoria, Mahonia leschenaultii* and *Gaultheria fragrantissima* are found only in the fringes. The occurrence of *Symplocos* spp. as a major species compliment in these forest patches indicates their sub-tropical or temperate affinities. The uniqueness of the community lies in the fact that tropical montane forests have many species which are restricted to tropical latitudes. Razi (1955-56) reviewed the probable centers of origin of various species found in Mysore hill tops and has shown that species like *Cinnamomum, Litsea, Meliosma, Neolitsea* and *Schefflera* to be of Malayan affinity, *Psychotria* and *Rapanea* of South American, *Pittosporum* of tropical and sub tropical. Thus tropical nature of the species ascertained while species in the open formations like grasslands and fringes seem to have origins in Sino-Himalayan region. Species like *Rubus* has high representation in Europe, Central-Asia, Himalayas, China and Boreal America, hence of temperate stock. Meher-Homji (1967) opines that most of the species of this community are of tropical stock which have restricted phytogeographical range. Some species of the temperate region present are the species with wide ecological amplitude.

According to Ramesh and Pascal (unpublished data), Nilgiri Biosphere Reserve lies in the second high concentration of endemics and has 5.2 % of species endemic. High levels of endemism in the Montane forests is a significant factor. This could be due to the climatic fluctuations that the plateau has experienced (Sukumar *et al.*, 1993). Endemics here are concentrated in the family Lauraceae which dominates the floristic composition of forest patch.

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